Executive Summary

A Review of the Economic Impacts of AOSIS-Type Proposals to Limit Carbon Dioxide Emissions

Prepared for:
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I. Executive Summary

Overview

As directed by the Conference of the Parties, the Ad Hoc Group on the Berlin Mandate is considering proposals to limit greenhouse gas emissions in the post-2000 period. For example, a group of countries called the Alliance of Small Island States (AOSIS) proposed a protocol to the Framework Convention on Climate Change that would require Annex I countries (OECD, eastern Europe, and former Soviet Union) to limit their carbon dioxide emissions to 20 percent below 1990 levels by 2005. This study compares and contrasts existing macroeconomic modeling studies which use carbon taxes as a proxy for the marginal cost of abatement to evaluate the potential impact of similar, but less stringent, emission reduction proposals.

This analysis indicates large economic costs would be incurred with adoption of an AOSIS-type proposal. The impact on the U.S. likely would be greater than for other Annex I countries and the economic and employment impacts of rapid emission limitations would be felt unevenly across geographic regions and industries within a given country. The authors conclude that:

For the United States:

- The tax rate to achieve an AOSIS-type target by 2005 likely would be in excess of $280 (1994 dollars) per metric ton of carbon emissions;
- Economic losses of 3-3.5% of GDP would be expected -- this is equivalent to a reduction of $262 billion to $305 billion in GDP per year in today's economy;
- The GDP loss (in 1994 dollars) would be $509 to $592 per metric ton reduction in carbon emissions;
- Energy intensive industries and their employees would be hit hardest.

For other OECD Countries:

- The economic effort required to meet an AOSIS-type target would vary substantially across countries;
- Reductions in GDP of 0.7% to 2.0% in 2010 could be expected, but countries with relatively rapid population growth would suffer greater reductions in GDP;
- GDP losses (in 1994 dollars) of $200 to $500 for each metric ton reduction in carbon emissions could be expected;

For Developing Countries:

- Developing countries would not be required to reduce emissions but they would be impacted by the domestic actions taken by Annex I countries;
- While this impact might not appear large in the aggregate, there would be clear winners and losers among developing countries with impacts varying substantially among "newly developed" and "developing" countries;
- To the extent that developing countries benefit from Annex I emission reduction efforts, their emissions would increase and offset Annex I country emission reduction efforts.

Alternatives to AOSIS-Type Proposals:

- Given the large economic impacts of proposals to rapidly reduce emissions, analysts, and policymakers need to look beyond the debate over immediate emission reductions and address issues of long-term timing of emission reductions and international cooperation.

Study Description

The Alliance of Small Island States (AOSIS) proposed a protocol to the Framework Convention on Climate Change that would require Annex I countries to limit their carbon dioxide emissions to 20 percent below 1990 levels by 2005. The proposal also calls for policies, but no specific targets, to reduce emissions of other greenhouse gases. This and other proposals would place binding limits on carbon dioxide emissions from Annex I countries; none of these proposals would impose any limitation on greenhouse gas emissions from developing countries.

This study compares and contrasts existing macroeconomic modeling evaluations of the potential impact of emission reduction proposals. None of the studies currently available for review investigated the impact of limiting emissions to 20% below 1990 levels over a such a short time span (less than ten years), so this analysis describes the economic impact of less severe restrictions. Most of the studies investigated the impact on economic growth of a 20 percent reduction in carbon emissions from 1990 levels by the year 2010. These results give an indication of the range of minimum impacts to be expected under an AOSIS-type proposal, and indicate the importance of assessments of the impact of proposals requiring rapid and deep reductions.

The Emission Gap: Agreeing to meet such proposals would likely have a significant impact, particularly on the U.S. economy. For example, U.S. carbon emissions in 1995 were 32% greater than would be allowed under the AOSIS protocol. In 2005, according to the Energy Information Administration's Annual Energy Outlook 1996 reference case, carbon emissions are projected to exceed an AOSIS-type target level (0.8 * 1337 = 1070) by almost 48%, even accounting for the "no-regrets" or "low-regrets" agenda developed and pursued under the Climate Change Action Plan.

U.S. Carbon Emissions
(Million Metric Tons)

1990	1337.2
1995	1413.2
2005	1585.2

Source: Annual Energy Outlook, 1996

Study Conclusions

All of the studies reviewed used carbon taxes -- a proxy for the marginal cost of abatement -- as the mechanism for reducing carbon from the energy sector, and all of the studies offset the revenue from the tax with reductions in other tax revenue sources. While other mechanisms might be used to achieve similar goals, economic theory indicates that they would cost at least as much as the carbon taxes assumed in these models.

The models reviewed here fall into two major categories: econometrically estimated partial equilibrium models and computable general equilibrium (CGE) models. In general, the econometric models provide insight into the economic costs of the carbon tax policy accounting, or perhaps concentrating, on the rigidities in the energy/economic system such as a long and costly adjustment process for the capital stock, while the computable general

equilibrium models indicate the long-run market equilibrium solutions for the estimated carbon tax and its associated economic costs.

The results of this analysis show a large economic cost to the U.S. associated with adoption of an AOSIS-type proposal. To achieve a reduction in emissions of up to 20% from the 1990 levels by 2010, the econometric models estimate tax levels of approximately $200-$400 (1990$) per ton carbon emission. The associated GDP loss is estimated to be 4.2% at its peak, averaging 3.5% for the period 2005-2015 (a more comparable number to the estimates derived from CGE models.) To achieve the same objective, most of the computable general equilibrium models estimate tax levels of $126-$306 (1990$) per ton leading to GDP losses in the range of 0.9%-1.5%. The DGEM and Goulder models estimate similar economic impacts although the carbon tax is not as large due to the rapidity of their market clearing mechanism.

Model Results for U.S. in 2010

	EPRI (94) DRI (92)		EMF12 (94) DGEM GOULDER		EMF12 (94) Rest of EMF12		OECD Study (92)	
	H	L	H	L	H	L	H	L
Carbon Tax (as reported)	$384 ($89)	$200 ($92)	$50 ($90)	$50 ($90)	$260 ($90)	$160 ($90)	$306 ($90)	$126 ($90)
Carbon Tax (in $94)	$450	$210	$56	$56	$292	$180	$343	$141
Loss of GDP (%)	4.2%	4.2%	1.7%	1.2%	1.5%	0.9%	1.3%	0.9%
1994 GDP Dollar Loss per metric ton reduction	$820	$591	$218	$154	$147	$94	$160	$117

Given the structural differences in the model types, we concluded that the tax rate to achieve a 20% emission reduction from 1990 levels by 2010 is likely to be between the lower bound of the range suggested by the econometric models and the higher bound estimated by the CGE models, or in the $200-$300 (1990$) range. The associated economic costs, therefore, are likely to be a reduction of 1.5%-3.5% of GDP. The models also suggest that the economic costs associated with emission reduction are likely to be relatively higher in the early years due to the stickiness of capital stock in adjusting to changes in energy prices. This implies that the costs of emission reduction for the year 2005 are likely to be closer to the upper bound of the range estimated for 2010. If imposed, a carbon tax of this magnitude would lower the projected level of GDP in 2005 by 3-3.5%.

Assessment of the Probable Impact on the U.S. Economy of Adoption of an AOSIS-type Proposal

	2005
Carbon Tax ($90/metric ton)	$250-$300
Carbon Tax ($94/metric ton)	$280-$336
Loss of GDP (%)	3% - 3.5%
GDP Loss[1] (billion 94$)	$262 - $305
GDP Loss / metric ton of carbon[1]	$509 - $592

[1] Calculated using baseline projections of real GDP inflated to 1994 dollars by the implicit price deflator and carbon emissions for 2005, EIA Annual Energy Outlook, 1996

U.S. Sectoral, Regional and Employment Impacts

While all the studies reviewed in this report examined the magnitude of the losses in real GDP relative to the baseline, as well as the losses borne by the energy sector, only one study, "Economic Impacts of Carbon Taxes: Overview and Detailed Results" prepared for EPRI by DRI/McGraw-Hill and Charles River Associates, investigated the impact of several large carbon taxes on sectoral and employment performance. According to the EPRI study, the carbon tax would have the most impact on employment in energy-producing areas. A $100 carbon tax would result in a 1.1% job loss relative to baseline levels by 2010 in the West South Central census region where oil and gas producing industries are concentrated. Regions where electricity is primarily generated from coal such as the East South Central and South Atlantic would also face a greater than average decline in manufacturing employment.

The impact of the carbon tax across industries will vary depending on their energy usage. The impact will be the largest on energy producing industries such as oil, natural gas, coal and electricity. Among non-energy industries, mining operations and industries in early stages of processing (such as chemicals) would be the most affected by the carbon tax.

Economic Impact on Rest of World of AOSIS-type Proposals

Rest of OECD: Comparison of the results for the U.S. and the Rest of the OECD indicate that the impact of a given reduction target would be greater for the U.S. Population increases represent the most direct demand for additional energy resources, and U.S. population growth is projected to grow nearly 0.9% per year. Another important element of a country's ability to meet carbon reduction targets is its current energy intensity. In the U.S., the bulk of the emission reductions through 2010 would be achieved through lower energy usage rather than fuel switching. Given the slow rate of turnover in capital stock over the near to mid-term (10 to 15 years), energy prices would have to rise considerably to induce reductions in use resulting in a significant slowing in economic growth relative to the baseline.

Model Results for Rest of OECD in 2010

	DRI (92)				OECD Study (92)	
	Japan	Australia	OECD-Europe	Canada	H	L
Carbon Tax (as reported)	$1100 ($89)	$783 ($89)	$600 ($89)	$431 ($89)	$240 ($90)	$129 ($90)
Carbon Tax ($94)	$1288	$916	$702	$505	$269	$145
Loss of GDP (%)	1.5%	3.9%	2.0%	3.2%	0.9%	0.3%
1994 GDP Dollar Loss per metric ton reduction	$725	$306	$495	$484	$326	$77

Note: Carbon tax values inflated by the U.S. implicit price deflator.

While the carbon taxes are significantly different between the DRI/McGraw-Hill study and the OECD study, the reported economic impact by country or for regions within the OECD is more similar. The range of impacts in the OECD study center around 0.7% in 2010. In the DRI/McGraw-Hill study, the impacts are higher: 1.5%-3.9% in 2010. The DRI study implies a

$300-$725 (1994$) loss in GDP per metric ton of emission reduction, while the rest of the OECD study results are $100-$326 (1990$) per metric ton. The major difference between the two studies is the treatment of the rest of the OECD in regions versus specific-countries. In the DRI study, the explicit investigation of the countries led to a conclusion that the ability of the other OECD countries to meet specific target over the near term was very limited. Due to the existing energy taxes in the rest of the OECD, limited opportunities for near term expansion of natural gas above levels already included in the base case, combined with the assumption of no trading of emission rights, results in a very leveraged impact on the level of the carbon tax needed to achieve significant emission reductions in the succeeding twenty years. Treatment of the rest of the OECD in a more aggregate form, often as one region, implicitly assumes greater flexibility in the region's ability to meet the goal.

Developing Countries: As an adjunct to the DRI/McGraw-Hill studies, analyses were performed to quantify the impact of carbon limitation programs in the OECD on developing countries. These analyses were performed to ascertain if the imposition of OECD fossil fuel taxes or restrictions would benefit developing countries.

The aggregate results for the world regions show little impact from the baseline in both studies. However, these aggregate results are deceiving: there are clearly defined winners and losers, and the disparity between the winners and losers begs for a reclassification of the countries between "newly developed" and "developing." Across the world, the newly developed have been identified as clear winners: countries positioned to take advantage of a self-imposed economic constraint within the OECD.

The losers, on the other hand, will not only suffer because of economic reversals within the OECD, but will require additional help from the OECD to support their economies, when the OECD will be in a worsened position to supply it. The developing world will not participate equally in the "leakage" of carbon intensive industrial activity from the OECD: the few winners take all. Finally, the shift in economic performance towards a few countries positioned to replace most of the industrial output formerly produced by the OECD results in world carbon emissions insignificantly reduced from the baseline.

Alternatives to AOSIS

Given the economic impacts cited above, both scientists and policy makers need to look beyond the debate over immediate reductions and begin to address the timing of reductions and international cooperation. Carbon dioxide concentrations, not annual emissions, influence global climate change. Therefore, by allowing greater flexibility in the timing of emission reductions, the cost of such reductions could be significantly reduced without changing the ultimate atmospheric concentration. An underlying factor related to timing focuses on the value of information, which means delaying draconian actions until scientific knowledge is improved and can reduce uncertainty, and thereby avoiding abatement costs that ultimately might not be needed. Also, the deferring of emissions reductions would provide valuable time to deploy low cost carbon free technologies.

In conjunction with the issue of timing, policymakers need to foster international cooperation among the OECD and the rest of the world. The potential cooperation among nations would lead to a more cost-effective way of attaining future carbon dioxide targets.

Attachment 1

Impact of Carbon Taxes on Energy Prices

Energy Type	1995 Prices Estimated	$100/Mt Carbon Tax 1995 Prices plus Carbon Tax	$100/Mt Carbon Tax Percent Increase	$280/Mt Carbon Tax 1995 Prices plus Carbon Tax	$280/Mt Carbon Tax Percent Increase	$336/Mt Carbon Tax 1995 Prices plus Carbon Tax	$336/Mt Carbon Tax Percent Increase
Petroleum (Cents per Gallon)							
Home Heating Oil	86.64	113.84	31.4%	162.80	87.9%	178.03	105.5%
Motor Gasoline	120.62	147.82	22.6%	196.78	63.1%	212.01	75.8%
Utility Residual Fuel	38.07	65.27	71.4%	114.23	200.1%	129.46	240.1%
Utility Residual Fuel ($/mmBtu)	2.54	4.36	71.7%	7.64	200.6%	8.66	240.8%
Natural Gas (Dollars per mmBtu)							
Residential	6.54	8.15	24.6%	11.05	68.9%	11.95	82.7%
Industrial	2.76	4.37	58.3%	7.27	163.3%	8.17	196.0%
Utility	2.10	3.71	76.7%	6.61	214.7%	7.51	257.6%
Coal (Dollars per mmBtu)							
Utility	1.33	4.08	206.8%	9.03	578.9%	10.57	694.7%
Electricity (Cents per kWh)							
Residential	8.47	10.27	21.3%	13.51	59.5%	14.52	71.4%
Industrial	4.73	6.61	39.7%	9.99	111.3%	11.05	133.5%

In this analysis, each $100 per metric ton carbon tax converts to:
Petroleum: $11.42 per barrel, $1.97 per mmBtu, or 27.2 cents per gallon;
Gas: $1.66 per mcf or $1.61 per mmBtu;
Coal: $56.60 per short ton or $2.75 per mmBtu.

Calculated from "A Review of the Economic Impacts of AOSIS-Type Proposals to Limit Carbon Dioxide Emissions," pages 3 and 12.

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Attachment 2

Comparison of Results for the U.S. Economy

Study	CO_2 Emissions	Carbon Tax (as reported, per mtc[1])	GDP Losses (from baseline)	GDP Dollar Losses (from current economy[2]; billion 1994 US$)	CO_2 Emission Reduction (from baseline, in million metric tons of carbon)	$GDP Loss/ CO_2 Emission Reduction (1994 $ per mtc)
EPRI (94) Carbon taxes phased-in, initiation in 1996 at $20						
$100 Tax	1.03*1990 in 2000	$100 (92$)	0.7% in 2000	48.26	110.0	438.73
	1.1*1990 in 2010	$100 (92$)	2.3% in 2010	158.60	269.50	588.50
$200 Tax	.99*1990 in 2000	$200 (92$)	0.9% in 2000	62.06	168.37	368.59
	.94*1990 in 2010	$200 (92$)	4.2% in 2010	289.61	490.0	591.04
DRI (92) Carbon emission targets defined at 10-year points; taxes initiated in 1994 at $24 (89$)						
	1.0*1988 in 2000	$120 (89$)	1.4% in 2000	96.54	106.0	910.75
	.9*1988 in 2010	$384 (89$)	4.2% in 2010	315.99	385.0	820.75
	.8*1988 in 2020	$721 (89$)	1.8% in 2020	124.12	618.0	200.84
OECD[3] (92) Taxes initiated in late 1990s						
CRTM	.82*1990 in 2010	$306 (90$)	0.9% in 2010	62.06	526.97	117.77
	.79*1990 in 2020	$294 (90$)	1.3% in 2020	89.64	852.56	105.14
ERM	.84*1990 in 2005	$95 (90$)	0.7% in 2005	48.27	370.06	130.44
	.70*1990 in 2020	$318 (90$)	2.0% in 2020	137.91	728.32	189.35
GREEN	.84*1990 in 2010	$126 (90$)	0.9% in 2010	62.06	507.01	122.40
	.75*1990 in 2020	$202 (90$)	1.1% in 2020	75.85	764.60	99.20
GLOBAL 2100	.86*1990 in 2010	$196 (90$)	1.3% in 2010	89.64	556.90	160.96
	.79*1990 in 2020	$321 (90$)	2.2% in 2020	151.70	858.02	176.80
EMF12[4] (94) Taxes initiated in late 1990s						
CRTM	.8*1990 in 2010	$260 (90$)	1.0% in 2010	68.96	601.02	114.71
DGEM	.8*1990 in 2010	$50 (90$)	1.7% in 2010	117.22	536.63	218.69
GOULDER	.8*1990 in 2010	$50 (90$)	1.2% in 2010	82.75	536.63	154.38
GREEN	.8*1990 in 2010	$170 (90$)	0.9% in 2010	62.06	658.26	94.32
GLOBAL 2100	.8*1990 in 2010	$240 (90$)	1.5% in 2010	103.43	701.19	147.55
GEMINI	.8*1990 in 2010	$330 (90$)	nc	nc	nc	nc
FOSSIL 2	.8*1990 in 2010	$250 (90$)	1.4% in 2010	96.54	658.26	146.72
Global Macro	.8*1990 in 2010	$130 (90$)	nc	nc	nc	nc
ERM	.8*1990 in 2010	$160 (90$)	1.1% in 2010	75.85	536.63	141.51
MWC	.8*1990 in 2010	$160 (90$)	1.1% in 2010	75.85	751.28	101.00

Legend:
1/ mtc: metric tons of carbon
2/ The GDP for the US is for the year 1994 ($6,895.5 billion curent dollars).
3/ CRTM - Carbon Rights Trade Model; ERM - Edmonds-Reilly Model; GREEN - OECD Model
4/ DGEM - Dynamic General Equilibrium Model; MWE - Model of Warming Commitment

ADDENDUM

Please note that a complete copy of the ***Review of the Economic Impacts of AOSIS-Type Proposals to Limit Carbon Dioxide Emissions*** study, can be obtained through the GCC offices at the following address:

1331 Pennsylvania Avenue, NW
Suite 1500, North Tower
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Phone: (202) 637-3158
Fax: (202) 638-1043

This study is also available on the Global Climate Coalition's World Wide Web page at:

http://www.worldcorp.com/dc-online/gcc